

Last name _____ First name _____ SID _____ GSI _____

Essay questions (40 pts): pick **one** and only one to answer and **circle** it. Start your essay on this side, and continue it on the other side. Cover the important points in a clear and concise manner – as if you have only a few minutes to tell the President, your roommate, or your parent, what that person needs to know. *Clear, effective writing is important.* If English is not your first language, state so at the top of your essay. The essay may be up to a page and a half long. If you need to re-write your essay, ask for a new sheet.

- 1. Sound channels:** Describe natural sound channels that exist on the Earth. Why do sound channels form? Who uses (or used) them? For what purposes? Give examples of other kinds of waves that show similar behavior.
 - 2. Invisible light** includes IR and UV. What are these? How do they affect our everyday lives? What are their practical uses and applications? Name two other form of invisible light, and name applications for each. Include medical applications.
 - 3. The laser** was an invention that has changed our every-day lives. What does the word "laser" stand for? What properties of laser light make it useful? What are the main parts of a laser? What principles of quantum physics make a laser work? List five current and possible future uses for lasers; make the list as diverse as possible.
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Circle the question, and begin your essay here.

Short questions (1 point each, 40 points total). Read the questions carefully so that you don't misinterpret them (e.g. by missing a word such as "not"). Enter all your answers on the Scantron form.

1. One food Calorie is approximately
 - A. 4 kilojoules
 - B. 4 joules
 - C. 4 kilograms
 - D. 4 grams
2. The force exerted on an astronaut who is in orbit 200 km above the surface of the earth is:
 - A. nothing, since astronauts are weightless in space
 - B. slightly less than on Earth because the force of gravity is less when you are further away
 - C. the same weight as a feather; that's why they float
 - D. the same as it would be on Earth
3. At the same temperature, sound waves move fastest in:
 - A. rock (granite)
 - B. liquid (water)
 - C. air
4. The escape velocity, the speed necessary to escape the Earth's gravitational field, is approximately:
 - A. 9.8 m/s
 - B. 100 m/s
 - C. 11 km/s
 - D. 300 km/s
5. The Global Positioning System has satellites in this type of orbit:
 - A. low Earth orbit
 - B. medium Earth orbit
 - C. geosynchronous Earth orbit
 - D. solar orbit
6. Liquid hydrogen compared to gasoline has
 - A. Three times more energy per gram
 - B. Three times more energy per gallon
 - C. A higher boiling point
 - D. Higher density
7. A helium nucleus has 2 protons and 2 neutrons. How many quarks, including up quarks and down quarks, are in a helium nucleus?
 - A. 2
 - B. 4
 - C. 6
 - D. 12
8. What is "Nemesis"?
 - A. a recently discovered planet that orbits the sun.
 - B. a theoretical star that orbits the sun, making comets and asteroids veer towards Earth.
 - C. an asteroid found near Pluto, not considered a planet.
 - D. a nearby galaxy that we can view with the unaided eye.
9. Neutron Activation is used to
 - A. detect radioactive atoms
 - B. detect neutrons
 - C. make neutrons radioactive
 - D. to detect non-radioactive atom

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10. Which of the following are true statements? A refrigerator
- A. makes the room it is in colder
 - B. does nothing to the temperature of the room it is in
 - C. makes the room it is in hotter
11. Microwave ovens use radiation with a wavelength
- A. about one micron
 - B. same as radar
 - C. same as lasers
 - D. same as AM or FM radios
12. What (approximately) is the average speed of shaking molecules in a material at room temperature?
- A. the speed of sound (330m/s)
 - B. the speed of light
 - C. 100 miles per hour
 - D. zero (they are at rest)
13. To get high efficiency from an engine for mechanical motion you need:
- A. small temperature differences between the surrounding air and engine
 - B. large temperature differences between the surrounding air and engine
 - C. about equal temperatures between the surrounding air and engine
14. Which of the following is not an electromagnetic wave?
- A. gamma rays
 - B. x-rays
 - C. alpha rays
 - D. UV
15. Why does the L wave usually cause the most damage
- A. It travels on the surface of the earth
 - B. It is a pure longitudinal wave
 - C. It has the longest wavelength
 - D. It is closest to the epicenter
16. Mark all the following which are NOT part of our "solar system":
- A. Jupiter
 - B. asteroids
 - C. the Andromeda Galaxy.
 - D. Halley's comet
17. We now know that an electron is made of
- A. quarks
 - B. gluons
 - C. strings
 - D. we don't know. It may be truly elementary.
18. Which one of the following is INCORRECT?
- A. TNT has more energy per gram than chocolate chip cookies.
 - B. Uranium-235 has 30 million times more energy per gram than TNT.
 - C. A computer battery has more energy per gram than a flashlight battery.
 - D. Gasoline has more energy per gram than any other everyday substance.

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19. What observations show that neutrinos have mass?
- A. Neutrinos being emitted in nuclear decays.
 - B. Neutrinos change from ordinary to exotic neutrinos meaning that they experience time.
 - C. Neutrinos have been seen to travel at the speed of light.
 - D. Physicists have not been able to prove that neutrinos have mass.
20. At very high speed, all of these change except
- A. length
 - B. mass
 - C. time
 - D. electric charge
21. Based on the linear hypothesis, approximately how many cancers were caused by the Chernobyl accident?
- A. less than 1,000
 - B. 24,000
 - C. 1,000,000
 - D. 24,000,000
22. According to our text book, the majority of mass in the universe is made up of:
- A. planets
 - B. stars
 - C. dark matter
 - D. comets
23. A big generator uses its own electricity to strengthen its magnetic field. Such a generator is called a:
- A. superconductor
 - B. transformer
 - C. samarium
 - D. dynamo
24. Lights and TVs in Europe tend to flicker because Europe uses
- A. 240 volts -- the US uses 120 volts
 - B. 120 volts -- the US uses 240 volts
 - C. 50 Hertz -- the US uses 60 Hertz
 - D. 60 Hertz -- the US uses 50 Hertz
25. Jane and Lane synchronize their watches on Earth. Jane remains on Earth while Lane takes a round trip to Pluto at near light-speed. When they get back together, whose clock is correct?
- A. Jane's clock (on Earth)
 - B. Lane's clock (on the spaceship)
 - C. both clocks are correct
 - D. neither clock (since the Earth is always moving too).
26. Which of the following can NOT be used to enrich uranium for a nuclear weapon? (Check all that apply)
- A. Calutron
 - B. Centrifuge
 - C. Diffusion plant
 - D. Nuclear breeder reactor
27. The microwaves in a microwave oven mostly heat
- A. carbon
 - B. air
 - C. water
 - D. oxygen
28. MRI maps the distribution of which element to produce an image?
- A. Iodine
 - B. Carbon
 - C. Calcium
 - D. Hydrogen

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29. Drake's Equation
- A. shows the Universe is expanding
 - B. gives the mass of black holes
 - C. calculates numbers for SETI
 - D. gives the amount of "dark matter"
30. The phosphor of a fluorescent light bulb turns _____ into visible light:
- A. x-rays
 - B. infrared light
 - C. ultraviolet light
 - D. alpha rays
31. A positron is
- A. an anti-electron
 - B. the same as an electron
 - C. a kind of quark
 - D. a hypothesized star
32. The "population bomb" appears to be ending. Our best guess as to why:
- A. increased cancer from radioactivity
 - B. lower birth rates
 - C. wars
 - D. AIDS
33. The China Syndrome refers to:
- A. Chinese development of nuclear weapons
 - B. a nuclear meltdown
 - C. fear of nuclear power
 - D. anti-nuclear activism
34. What is the cause for "windburn"?
- A. cold from the wind
 - B. friction from wind
 - C. solar UV
 - D. solar IR
35. Which of the following events is not caused by a chain reaction process?
- A. snow avalanche
 - B. lightning
 - C. tunneling
 - D. laser emission
36. The photon has a rest mass approximately equal to:
- A. the mass of an electron
 - B. 0.000003g
 - C. 0
 - D. 3.14 g
37. Gluons, which hold together protons, represent which force?
- A. strong
 - B. gravitational
 - C. electromagnetic
 - D. weak
38. Project Mogul used:
- A. a sound channel
 - B. integrated circuits
 - C. reflections from nuclear explosions
 - D. large holes in snow from skiers
39. The most dangerous part of nuclear fallout consists of:
- A. neutrons
 - B. cathode rays
 - C. nuclear tunneling
 - D. fission fragments
40. Sea level is rising primarily because
- A. melting ice is adding more water to the oceans
 - B. oceans are warming and expanding
 - C. continents are expanding, and that shrinks the space for the oceans
 - D. we don't know why